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DEVELOPMENT OF ELECTRONICS

IN

TANZANIA*

prepared by

Octavian S. Mageni**

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** Acting Head, Metals and Engineering Sector, Ministry of Industry and Trade, Dar-es-Salaam, Tanzania.

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1. INTRODUCTION

Under normal circumstances, the mechanical and electrical engineering industries are fairly closely linked. Originally mechanical equipment was either manually operated and powered or driven by some simple natural process, for example water or animal power (e.g. water pumps). With the introduction of electric power, this was immediately adopted for powering the machine. This led to the development of electro-mechanical technologies. However because of the requirements for greater quality control, mass production and economies of scale, there has been an increasing tendency to replace mechanical parts by electrical parts.

Now, since 1970, there has been a rapid tendency to replace electrical parts with electronic parts. In the 1980s simple analogue electronic parts will be replaced by digital electronic parts and complex micro-processor equipment. To some extent, electrical engineering is replacing mechanical engineering in the development world and Tanzania will shortly inherit this trend too. Electrical engineering is therefore the "cutting edge" of mechanical engineering technology and should be viewed as a natural chronological development of the mechanical engineering industry.

For the case of Tanzania, electrical energy and equipment is employed in four main sectors as follows:

- Energy generation and distribution
- Industrial Development
- Telecommunications and Radio
- Domestic and Services sector.

However, Tanzania has experienced an acute shortage of trained manpower and repair facilities for new and complicated electric and electronic equipment now being increasingly introduced in Government Organizations and private industry. Another major problem is that there is a very great diversity of equipment and its applications in Tanzania and the difficulties encountered in trying to

determine the amount and type of equipment in use in Tanzania today. There are more than 800 industrial concerns employing more than 10 persons in Tanzania today. Virtually all of these use electrical energy and electrical/electronic equipment in various forms as the equipment have been imported from very many sources. Some industries use very old and simple British electrical equipment, others have imported the latest Italian process equipment, many use Japanese Components, others employ East European electronic parts.

These problems make it difficult to forecast both the size of demand for electrical/electronic repairs and maintenance services and the type of demand. The same problem applies to determining what types of electrical industrial production is appropriate to Tanzania today. The dynamic development in industrial design in developed countries from which Tanzania imports most of its electrical and industrial equipment make it similarly very difficult to forecast trends in the demand for repair and maintenance.

The importation of micro-electronics (Integrated Circuits) equipment in Tanzania is just at its early stage and from this basis, this report tries to reveal the present position and the use of electrical/electronic parts in Tanzania. Efforts on the attempts to manufacture locally some of the components are also discussed with a major recommendation of establishing a National Repair and Maintenance Centre so as to increase the life time of the machines and equipment we have.

2. TANZANIA's INDUSTRIALISATION STRATEGY

The basic structure of the manufacturing economy in Tanzania is still a reflection of Tanzania's Colonial history and the predominance of agriculture in the overall economy. However, there has been a clear qualitative change in methods of production and in production itself since the early years of independence State intervention in e.g. textiles, leather goods, chemicals and metal industries has implied heavy investment in these sectors and in production of equipment and plant. This in turn, has had a marked effect upon the demand for electrical energy in industry.

Tanzania's policies for industrialisation can be summarized in the following main points in order to see the logic in the overall industrialisation process.

– Tanzania's electrical power resources are being extended rapidly both to produce more power and to distribute power to rapidly industrialising areas e.g. Mwanza, Mbeya and Kilimanjaro. As 62% of the power consumed today in Tanzania is utilised by industry, such a development is essential.

- Basic energy sources e.g. Coal are to be developed at Liganga in order to fuel the basic iron and steel industry. This may also be supported by hydropower from Stiegler's Gorge.
- Basic energy sources e.g. Coal and hydropower are to be built up to reduce Tanzania's crippling dependence on imported overseas oils.
- Tanzania is proposing to produce 300,000 to 500,000 tonnes of steel per annum using its own energy and raw material resources. Steel is one of the "basic building blocks" of machine industry whether it be mechanical or electrical.
- Tanzania has already established several metal fabrication industries which are essential for machine manufacture e.g. Aluminium Africa, Tanga Steel Rolling Mills etc.
- Tanzania was proposing to develop petrochemicals and possibly PVC production and this may be promoted by the development of the Songo-Songo gas field.

  These materials are also very important in the development of mechanical and electrical engineering production.
- Tanzania has already developed a wide variety of consumer industries producing for the domestic market and these are saving valuable foreign exchange.

There is thus little doubt that Tanzania has the basic elements and manufacturing inputs for a mechanical/electrical engineering industry in terms of raw materials, steels, aluminium, plastics and energy from various different sources. In addition the country is developing its manpower resources through numerous University, College and vocational training courses in electrical engineering. The

groundwork for the development of an electrical engineering strategy is therefore in place in Tanzania.

Industrialisation policy in Tanzania therefore visualises a substantial shift in structure from a processing economy to one capable of producing the means of production and basic raw materials, e.g. iron, steel, processed metals, petrochemicals etc. These industrialisation policies will increase demand for electrical and electronic equipment in industry enormously. Industry will grow both in size and in the scale of intensity of electrical equipment. However, as it is not known today how much such equipment is used in industrial production, it is difficult to make any reasonable forecasts of future use.

3. PRESENT OBSERVATIONS:

3.1 THE INDUSTRY SECTOR: The following observations can be made from various industries in Tanzania:

- Machinery came from a large number of different producers in many different countries e.g. Japan, UK, USA, Italy, France, Belgium, Sweden, Norway, Finland, Holland, Bulgaria, India, Pakistan, the Federal Republic of Germany, Yugoslavia, Denmark etc.
- A considerable amount of multi-operational machinery, based on flow-line production principles had already been introduced and this tendency is increasing.
- Much industrial production machinery which previously had mechanical regulating controls is now fitted with electronic controls.
- Electronic fault-finding is becoming a problem with much industrial production machinery.
- Shortages of spare parts (especially electronics) affects most establishments but not all.
- Re-winding of motors is a problem with some of the older machinery.
- Older well established firms with simple mechanical equipment have relatively few machinery problems.
- Lack of proper instrumentation is a constant problem throughout the industries.

- Fluctuations in voltage in the public electrical supply system is causing substantial problems throughout the country, especially for delicate electronic equipment.
- It is difficult to obtain appropriately designed production machinery for Tanzanian Conditions, - most of this type is now out of stock. If it is obtainable, e.g. UK machines, it is very expensive.
- Changes in design of different models of machinery in Europe had an impact in Tanzania because of the discontinuation of particular lines of spare parts.

The diversity of suppliers of electrical production equipment is also becoming a problem. Tanzania is frequently obliged to buy from countries and suppliers which can offer the best credit facilities. This accounts for the very wide diversity of equipment in the country. This makes the interchangeability of parts very difficult and the standardisation of parts even more difficult. If one country can offer suitable financial terms for a particular industrial production process, it is very tempting to select this process whether Tanzania has trained technicians or equipment to operate and repair it or not. This is a difficult problem which is likely to increase in the future.

TECHNOLOGICAL AND DEVELOPMENT TRENDS:

It seems likely that the content of electronic equipment in machinery imported in Tanzania will increase faster than the actual amount of machinery imported. This is because the proportion of electronic equipment in industrial production machinery is rising rapidly in the industrialised countries which export machinery to Tanzania. The development of prices of electronic components are making it more and more economic to include more and more electronic components in industrial process machinery in the industrialised countries and this is where Tanzania obtains its machinery.

There is thus little doubt that industrial production equipment imported into Tanzania in the future will contain a higher content of electronic components than previously. Indeed, if importing from the industrialised countries it may well be impossible to import equipment without electronic equipment.

3.2 THE SERVICES SECTOR

By the "Services Sector", I mean electrical equipment which is used for domestic purposes, i.e. consumer electrics and electronics, e.g. radios, cookers, ovens, hot plates, water heaters and other domestic appliances and fittings e.g. domestic switches, low-voltage switchgear and fuses etc. The terms also covers Social and Economic Infrastructure, i.e. the electrical equipment required in the tertiary services sector of the economy, i.e. hospitals and health services, Universities and education and other public sector services, water supply and agriculture e.g. irrigation pumps etc.

Tanzania has a very limited production in this sector, and it is limited to the assembly of radios by National (Matsushita) in Dar es Salaam and by Philips in Arusha, and to the assembly of fuse-boxes and smaller switch-gear by Northern Electrical Manufacturers in Arusha.

Apart from the assembly and further production of mass consumer goods like radios, the production of domestic consumer electric goods would not seem to be a national priority at the moment, because of the luxury aspect of the product. This, of course, does not apply to the production of domestic low-voltage switchgear and fittings which is a very different type of product in a rural electrification programme.

DEVELOPMENT TRENDS

The growth in consumer electrics and electronics is likely to take place most in the radio and cheap domestic appliance sector. Other, more expensive consumer goods, e.g. refrigerators, air-conditioning systems etc. are likely to grow more slowly and cannot be regarded as a priority in today's economic development. Domestic and low-voltage switchgear is growing in demand, and there may be scope for limited production in Tanzania to substitute for imports. Repair and maintenance of these

items seems adequately covered by the commercial sector.

DIVERSITY PROBLEM

As stated earlier, this is a very diverse sector including health and hospital sectors, Universities and schools and other public sector operations. This sector is characterised by the use of fairly simple electrical and electro-mechanical equipment e.g. water pumps, irrigation equipment, low-voltage equipment for public buildings etc. It is not known to any degree the extent of the use of electrical equipment in social and economic infrastructure, but little of it is very difficult to repair or maintain and there are already several institutions like the Ministry of Communications and Works and the Ministry of Water, Minerals and Energy who maintain their own workshops.

3.3 THE TELECOMMUNICATIONS SECTOR

The use of telecommunications in Tanzania is very widespread and and is to be expected in such a large country. The main users of such equipment include: Posts and Telecommunications Department, Extelcoms (external telephone, cable, radio links), Tanesco, Directorate of Meteorology, Directorate of Civil Aviation, Radio Tanzania, Air Tanzania, Police Signals Office, Tanzania Railways Corporation, Tanzania Harbours Authority, Aeradio Tanzania Limited, Tanzania Cotton Authority, some ranching schemes, prisons etc.

DEVELOPMENT TRENDS

New more effective types of electronic equipment, components and technical parts are arriving on the market at steadily lower prices. The micro-processor which can be described as a "Computer in miniature" will, in future, be one of the most important parts of the telecommunications equipment which is on offer to Tanzania. Future telecommunications technology will be based on Computer technology. Full use of computer technology's possibilities assumes that Communications signals will be sent in the form of data - or as it is often termed - "digitally".

The main features of the technological development within telecommunications in the developed world (which will thereby have a profound effect on what is available to Tanzania) are the following:

- use of Semi-Conductors and microelectronics;
- use of computer technology and digital communications technology;
- telecommunications satellite technology;
- use of fibre optics (laser technology).

The introduction of such new technologies will give considerable financial savings in the following fields:

- greater capacity per system unit;
- lower costs per capacity unit;
- greater reliability;
- lower operations and maintenance costs;
- a volumetric reduction in equipment and thereby the overall need for buildings to house such equipment.

The trends described above will obviously have their impact on Tanzania who import almost 100 per cent of their telecommunications equipment from these countries where such changes are taking place. Tanzania will therefore automatically import the new technologies and their specialised needs for repair and maintenance.

4. IMPORTATION OF ELECTRICAL SPARE PARTS

Maintaining adequate standards of repair and maintenance in energy supply, telecommunications, industry and the service sector is totally dependent on the continuous and uninterrupted supplies of electrical and electronic spare parts. However, it should be recalled that, apart from the assembly of components, Tanzania has no electronics production to-day.

Imported spare parts are available in Tanzania through three different channels as follows:

- the state purchasing organisations of BHESCO, AISCO and DABCO.
- private import by individual companies (most usual method).
- import to foreign-assisted projects through credits or grants.

In future, this is in fact not our main goal as Tanzania, in its industrialisation process, must use electrical equipment. Thereby it must reduce its dependence on overseas and develop its own capabilities for repair, maintenance, part and machine production.

Given Tanzania's shortage of foreign currency to import electrical spare parts , it is tempting to consider production of spare parts as part of an import substitution programme. It is clear that, if Tanzania is to industrialise, something must be done to improve the spare parts situation, and in order to keep the thousands of new machines which will be imported in the next 20 years, running. Three actions seem possible.

These are:

- to produce more electrical spare parts in Tanzania;
- to gear purchasing policy of machinery much more towards standardisation and interchangeability of spare parts.
- to set even higher priority on the import of spare parts and to develop a "spare parts bank" in Tanzania.

5. PRODUCTION OF SPARE PARTS

The primary objective of a strategy for the Electrical and Electronics Industry in Tanzania must be to make the country as self-sufficient as possible in the production of electrical equipment, production of spare parts and repair and maintenance of equipment, as is technologically possible. This means developing a strategy to build an industry which is not indigenous to Tanzania. Such a strategy is already implicit in Tanzania's long-term development plans and frequent mention is made of "establishing basic industries" in the Ministry of Industries and Trade's various policy statements on the development of the Metals and Engineering Sectors.

The purpose in developing the engineering sectors in general is to give Tanzania the capacity to produce its own capital goods equipment i.e. equipment which can produce goods and equipment which can produce other machines. Until Tanzania is capable of this it will also be at the mercy of outside forces and outside suppliers.

As far as electronic spare parts are concerned, there is no production in Tanzania as yet. This is the same story even in the industrialised world where you find few countries are completely self-sufficient on electronic spare parts. For the case of Tanzania the production of electronic spare parts is hindered by a number of reasons as follows:-

- the economies of scale in component production are

completely different from those in mechanical component production. Production requires very large runs and on intercontinental market. It also requires an active research and development engineering environment.

- Tanzania has imported electronic equipment of very many different origins and nationalities. It is difficult to standardise electronic parts and to interchange components. Demand for individual types of components are thus very small and hardly economic to produce.
- There are probably insufficient trained personnel to operate such production.

PRESENT CAPABILITY

The only industry producing electrical spare parts is the Tanzania Cables Limited of Dar es Salaam. This Company produces electrical wiring of all types including domestic wiring low tension transmission wires up to 1KV, enamelled wires up to 42 grade, aluminium conductors and overhead conductors and copper cables and copper enamelled wires. It was hoped to expand production into telephone cable, PVC wire, domestic switches, auto-wiring and small motors.

It is very clear that Tanzania Cables production of spare parts is of vital importance to Tanzanian industry, electricity generation and telecommunications and can form the basis of industrial production of electrical spare parts.

Northern Electrical Manufacturers (NEM) in Arusha are a promising venture, hoping to develop electrical production for the domestic market. They already produce fuse boxes with materials imported from Sweden and Norway and cable boxes and aluminium cable ducts, using materials from Aluminium Africa in Dar es Salaam. They also intend to start producing Ceramic fuses from local materials.

Because TANESCO's demands for spare parts is extremely high and largely dependent on the import of parts, attempts have been made to produce parts in the TANESCO workshops e.g. cross arms, shackle straps, earth and galvanised masts, earth rods, boards etc. However, spare parts for purely electrical or electronic machines cannot be produced by TANESCO. The complexity

of products like electric and electronic relays, inverters and regulators make it difficult to produce such capital intensive products in small runs.

Also, there have been discussions in Tanzania on the production of small motors for industrial purposes. It appears that Tanzania Cables is considering small motor production in the near future and PEMACCO in Mbeya has established a motor re-winding and assembly shop with a view to developing motor manufacture at a later stage.

5.1 SERVICES SECTOR

As mentioned before, the services sector is a very diffuse one including domestic and consumer electrics, and social and economic infrastructure i.e. all electrical equipment used in the health, education and other public sectors.

The repair and service of consumer electrical and electronic goods are, as in other countries, undertaken by a great many small, privately - owned workshops in Tanzania. These belong largely to the informal sector and are concentrated in Dar es Salaam where the market is largest.

The basic raw materials for the manufacture of domestic electrical equipment i.e. ceramics, plastic, aluminium etc. are already available in Tanzania, and at least one industry Northern Electrical Manufacturers of Arusha has already started production of simpler equipment. The scope for production in this sector appears therefore to be:-

- Screw fuses of all types;
- Domestic ceramic insulators;
- plastic plugs and sockets;
- Domestic insulated wire;
- Wall outlets.

PROBLEM:

The electrical equipment content of the services sector is so diffuse and the requirements for personnel and equipment and training are so diffuse that it would be extremely difficult to centralise repair and maintenance facilities. It also appears that most institutions in this sector are trying to develop their own

specialised repair capacity by developing their own sectoral workshops. It would be extremely difficult and very costly to develop a repair centre for both railway telecommunications equipment and hospital equipment as the technologies and specialisms are so different.

5.2 ENERGY SECTOR

The following products seem to be necessary and possible to produce in Tanzania:

- Insulators of all types;
- Mechanical hardware for transmission lines;
- Kilowatt Hour meters;
- Small AC - motors;
- Spare parts for generator and motor rewinding e.g. coils, brushes, varnishes etc.;
- High and low voltage fuses;
- Power voltage regulators;
- Electronic voltage regulators;
- Batteries (are already produced in Tanzania by National in Dar es Salaam);
- Power supplies.

5.3 INDUSTRY SECTOR

The structure of manufacturing industry in Tanzania is typical of many other developing countries in Africa. It is characterised by a concentration on the processing of natural resources which constitute about 70 per cent of the value of production.

PROBLEM

As far as electronic component production is concerned, it seems rather unlikely that Tanzania could embark on production in this field for the reasons below:

- the international free trade character of the market;
- the need for an active research and development environment;
- the relatively small internal market in Tanzania;
- the concentration of to-day's production in a few highly competitive nations in South -East Asia.
- the high investment required in tooling and production equipment.

RECOMMENDATION

Certain simpler components, however, could probably be manufactured in Tanzania and these include the following:

- Assembly and duplication of printed circuit boards;
- Moving and fixed contacts for starters;
- Transformer winding coils;
- Insulators of all types;
- Single and multicontact relays;
- Fuses of all types;
- Kilowatt Hour meters;
- Switches;
- Plugs and sockets;
- Insulated wire.

There is already a basis for production in Tanzania for most of these components, either in the metal working industry or the electrical machinery industry. However, feasibility studies of these components should be carried out.

5.4 TELECOMMUNICATIONS SECTOR

The electrical and electronic technology employed in the telecommunications sector is generally more advanced than in other sectors so that it is more difficult to recommend components for production in Tanzania which do not involve advanced electronics. However, many components in the telecommunications sector are common to other sectors and the main needs for parts production in this sector are found to be the following:

- mechanical and electronic relays of all types;
- transformers;
- power generating sets;
- coin boxes;
- rectifiers;
- Voltage stabilisers.

It is recommended that the production of the following components will be of value to the sector:

- carbon film resistors of all denominations;
- polyster type capacitors;
- power resistors;

However, feasibility studies should be carried out before the production of these elements, in combination with studies done for the other sectors.

5.5 PRIORITY PRODUCTION SECTORS

It has already been indicated in this paper that there are approximately 20 components spare parts within the electrical industry which could possibly be manufactured in Tanzania drawing on all sectors for their market. It is recommended that priority be given to the following parts because of their potential and because of the critical need for these in Tanzania:

- Mechanical hardware for the energy sector;
- Simple meters;
- Domestic and household switchgear;
- Fuses;
- Insulators;
- Small AC-motors.

All these components would assist the development of the electrical industry in Tanzania and assist in developing an "electrical environment" which does not exist to-day.

6.0 REPAIR AND MAINTENANCE

More and more manufacturers of production equipment in the developed countries from which Tanzania gets the bulk of its equipment are moving towards electronically controlled process equipment. Such equipment is simple to maintain and repair in an economy where there is an easy international interchange of know-how parts and components. This is not so easy in Tanzania where there is currently a premium on foreign exchange. By importing advanced electronically controlled production equipment, Tanzania is being pulled into an international market place of which it is not fully a part and where it has the lowest order of priority.

Tanzania's policies for industrialisation over the next 20 years will naturally have a very strong bearing upon the need for maintenance and repair facilities for electrical and electronic equipment. Both the future size and the future structure of industry will affect this need. The Fourth Five Year Plan (1981-1986) estimates

that the manufacturing industry sector will grow at between 7-9% per annum.

Some of the Government and private users of sophisticated electronic technology have been experiencing problems in the way that expertise and spare parts for repair and maintenance have not been available.

Attitudes to the importance of maintenance and repair of all equipment (not only electrical) vary enormously from sector to sector and from individual production unit to individual production unit.

In Tanzania, the repair and maintenance sector generally has a low status, as in most countries. This may be a feature of Tanzanian society inherited from earlier times. However, with the shortage of trained engineers in Tanzania today, it is much more tempting for the graduate to move into the fields of production and research and development rather than maintenance and repair. The former field is much more interesting in itself and it is usually better paid. This is one attitude which may have to change. In its present economic situation, Tanzania simply cannot afford to down-grade maintenance and repair of productive equipment.

6.1 SERVICE SECTOR

As to repair and maintenance of domestic electrical equipment, there appear to be adequate facilities in most towns in Tanzania. Dar es Salaam contains numerous workshops specialising in the repair of domestic electrical equipment, as this is an attractive commercial market for most small entrepreneurs, and the market is well covered.

6.2 TELECOMMUNICATIONS SECTOR

Repair and maintenance efforts in the telecommunications sector, encounters various problems particularly in the following field:

- lack of spare parts, especially electronics;
- lack of tecnical staff;
- lack of trained technicians and lack of training;
- problems with environment (voltage fluctuation etc.)
- assistance needed on instrument repair/calibration.

The maintenance and repair of telecommunications systems is known to be a complex problem, - much more than in developing a new project. What is more, unlike the development of a new system, which may take only a couple of years, maintenance and repair calls for a lower key, but nonetheless sustained and prolonged effort.

In the modern world, there is an increasing complexity of electronic equipment and technologies which are steadily coming on offer on the internationdl telecommunications market. This is a tendency over which Tanzania has very little control. However, as stated above, the country should endeavour to maximise the use of that equipment it already possesses.

6.3 INDUSTRY SECTOR

The following conclusions can be drawn in examining the maintenance and repair facilities in Tanzania industries:

- Most industries have tried to establish electrical/electronic workshops to repair and maintain production equipment;
- Some industries have little or no electrically qualified staff for electrical/electronic repairs e.g. qualified graduate engineers;
- There is a general shortage of experienced and trained electricians and electronics technicians throughout the industry;
- Lack of spare parts is a recurrent problem throughout industry;
- There is very little fault - finding equipment e.g. oscilloscopes available for electronics repairs;
- Most electronics repairs are very difficult either because of lack of equipment and/or experience. There is no production of electronic spare parts in Tanzania;
- Much electronics equipment is either sent to private workshops in Dar es Salaam or abroad to the suppliers for repair;
- There is a very great need for competence in instrument repair/ calibration;
- Tanzania is facing serious foreign exchange difficulties because of factors beyong its control;
- The changes in industrial structure are leading to an increasing use of electrical energy and thereby electrical equipment in Tanzanian industry;

- Industrial location in Tanzania is strongly influenced by the availability of electric power, i.e. in the coastal region and Lake region. Industry is the principal user of electric power in Tanzania, so that its distribution will affect the distribution of electric power;
- The electrical and electronics sectors seem to be highly dependent on non-citizens, so that the country is highly dependent on non-citizens to keep its industry running as technologies become more and more complicated;
- Tanzanian industry has a reasonable capacity for the repair of electro-mechanical equipment, power supply (transformers, switchgear, cables and distribution pannels etc) and the rewinding of small motors;

All of these factors point to an increasing sophistication of Tanzanian industry and consequently further electrification and use of electrical equipment. At the same time, difficulties with foreign exchange will make it increasingly difficult to carry through this electrification of Tanzanian industry. A basic principle of Tanzanian industrial policy must therefore be to prolong the working life of electrical production equipment so as to maximise the benefits of investment in a scarce imported production unit. This makes effective repair and maintenance of electrical production equipment in industry an absolute necessity in pursuing national industrialisation policies.

The availability of spare parts, fault-finding equipment and the import of new equipment are all closely related. Because decisions to import new industrial process equipment are not usually taken by the people who will have to repair it, and because more and more imported equipment is electronic, the development of electronics workshops and the appropriate fault-finding tools will certainly lag behind the import of machinery. This in turn, will generate a larger demand for spares, - where it proves impossible to find faults and to repair. This combined with a lack of specialised manpower will make it doubly difficult to develop electronic workshops.

7. TRAINING FACILITIES FOR ELECTRICAL/ELECTRONICS ENGINEERING

The following are the main sources of training available to electrical/electronics/telecommunication engineers and technicians:

- Overseas courses with universities colleges or suppliers;
- Kidatu Technical College (TANESCO);
- Dar es Salaam Technical College;
- Dar es Salaam Vocational Training Centre;
- Arusha Technical College;
- University of Dar es Salaam;
- High Precision Technology Centre;
- Posts and Telecommunications Training Centre.

The training abroad is generally paid for by the supplier and Tanzania should insist that this is done every time a new piece of major equipment is to be commissioned.

TWO PROBLEMS

The first is the background of many of the students. Most students should first obtain some practical experience before starting courses unless the students are to become too theoretical. A second problem is that there is still probably insufficient advanced electronic equipment available in individual industries to give graduate engineers practical on-the-job training. This is particularly true of digital electronics which is not yet present in any degree but which will come in quickly.

8.0 FEASIBILITY STUDIES

It is recommended that feasibility studies be undertaken on the production of certain basic spare parts. The purpose of these studies would be to ascertain the financial and economic viability of production and to develop the basis for an electrical manufacturing industry in Tanzania. Feasibility studies should be carried out into the production of the following components/parts:

- Fuses of all types;
- insulators of all types;
- plugs, sockets and switches
- Low voltage Voltage Regulators;
- Mechanical/Electromechanical parts for the energy sector;
- Simple meters;
- Domestic and low voltage switchgear;

- Single and multi-contact relays;
- Small AC-motors.

9.0 RESEARCH AND DEVELOPMENT

However, because of Tanzania's peculiar situation in relation to technology in the developed countries, it may also be appropriate to concentrate more attention on research and development. In all developed countries, research and development takes place before production. Maintenance and repair routines are often worked out in parallel with research and development processes so that maintenance and repair facilities and capability is in place when the first machines come off the production line.

In Tanzania production is taking place on the basis of research and development undertaken in other countries for other purposes and for other environments. To some extent then, Tanzania is beginning to produce and certainly to import before any appropriate research and development. Any research and development of the appropriateness of technology is taking place after the import or production of the part. This, of course, means that repair and maintenance routines are not appropriate or in place and have to be improvised.

10.0 AN INSTRUMENT BANK

Many of the Tanzanian industries have very considerable problems with instruments. Either they have no instruments at all, because their use for them is so limited that it will be uneconomic to purchase them. Or they have them but they have serious problems in their operation, repair and maintenance. In such a situation it would seem logical to rent (from a national body), rather than to own such advanced equipment for the periods it is required.

11.0 RECOMMENDATIONS AND CONCLUSION

Since the electrical/electronic equipment are inevitably used in various sectors such as industry, energy, telecommunications and service and since these sectors represent an essential function within the economy of Tanzania, it is clear that a requirement exists for the establishment of:

- Centralised facilities for electrical/electronics repair and maintenance service within Tanzanian industry.
- Undertakings to manufacture selected electronic and electrical compqnents which have been suggested in this paper when found technologically and economically viable.